seen that a faint absorption extends as far as 650, and very likely the termination of this shade is a band. Fig. 6 represents the spectrum of a sample of pure absolute alcohol. Ordinary methylated spirit gives a very similar spectrum, differing only in the presence of some general absorption, and with a mixture of equal parts of methylated spirit and water the alcohol band was still clearly visible, and only a faint indication of the water band.

On referring now to the alcoholic solution of ammonia (Fig. 3), it will be seen that the probable explanation of the darkening of the 630 band is owing to the coincidence of the alcohol band with that of the ammonia, so that really the marked difference of the two ammonia spectra is in the absence of the 610 band, and this, we have seen, may be accounted for by one being an aqueous and the other an alcoholic solution.

Ethylic alcohol giving this definite band, it was a matter of much interest to examine other alcohols belonging to the same series. We found that amylic alcohol ($C_5H_{11}HO$) gave a single visible band (Fig. 5), which in character is like the one given by ethylic alcohol, but differs in position; it extends from 638 to 630, the centre being 634, so that it is decidedly nearer to the red end of the spectrum.

A sample of amylene (C_5H_{12}) gave also a band in the same position as that of the alcohol, but it differs apparently in being broader and less defined at the edges.

The sample of methylic alcohol was not quite pure nor free from colour, but it gave a band quite similar to that of the other two alcohols. Its position is certainly very nearly the same as that of the ethylic alcohol, but as far as our measurements went it was a little nearer the blue, but with our method of measuring hardly discernible.

It seems—pending further investigations—highly probable that this band—and of course there may be others not visible—is common to all the alcohols of the ethylic series, and that its position is a function of the density of the particular alcohol. Apparently however the significance of this line does not stop here, for in ordinary ether there is a band coincident with this alcohol-band—in fact practically the visible spectrum produced by alcohol and ether are identical; but in all cases that we have seen the ether spectrum is clearer and sharper than the alcohol one. We thought it of importance to examine a sample of ether which should be as far as possible rendered pure by ordinary means, especially that it should be free from all traces of moisture: this sample gave a band precisely similar to the band in the ordinary commercial ether. Another sample of ether was saturated with water: in this case the ether band was as marked as ever, but the water-band was not visible.

We have also examined two other bodies which belong to the ethylic series, namely, aldehyde and acetic acid. Both give bands, but they are not so clear or definite as the alcohol or ether bands. Figs. 8 and 9 show these bands. The aldehyde band commences sharply at 628, but on the other side it shades gradually off and ceases at 620. The band in acetic acid is very faint, in fact at first, when using the 6-feet tube, we were led to think there was no visible band.

We also tried a few of the saline ethers, and, as far as our investigations have gone, the ethyl compounds give a band coincident with the alcohol- and ether-band. And the band of the amyl compounds is coincident with that of amylic alcohol. There appears, however, to be this general difference between the bands in the alcohols and those in the corresponding saline ethers, namely, that in the latter the bands are always broader and less distinct; the saline ethers we have examined are ethyl oxalate, amyl acetate, amyl iodide, and amyl nitrate.

Passing now to the aromatic series, we find that they give very marked absorption bands. Fig. 9 represents the bands given by benzene; the spectrum is remarkably sharp and clear, quite as clear as the ether spectrum; the figure is drawn from the spectrum produced by 8 feet of the liquid. The absorption extends as far as 656; the first band is from 707 to 698, the second from 609 to 605; both are very dark and distinct. The third band extends from 531 to 528, and is very much fainter.

Toluene, the next higher member of this series, gave also a similar spectrum, and it is equally sharp (Fig. 10). As in the case of the alcohols, with increase of density the bands have moved nearer the red. It will be seen that the band in the red differs in position from the corresponding benzene band more than either of the other two bands do.

Cresol, unfortunately at present, we have not been able to examine for want of a sufficient quantity of the pure substance.

Phenol gives a spectrum very similar to the benzene spectrum; possibly the band about 610 is somewhat nearer the blue, but beyond this we could see no difference. In the first instance we tried melting the phenol, but afterwards found it far preferable to keep it liquid by the presence of a mere trace of water.

We looked with much interest to the two following experiments, with bodies of this series, namely, aniline and toluidene, to see how far their constitution might be indicated by their spectrum. Figs. 11 and 12 give respectively the spectra of these bodies. There is a band in the red in the same position as the toluene band, and in the case of aniline a band agreeing in part with the 606 benzene band. With toluidene, however, this band was not visible, but probably this arose from its being hidden by general absorption, the liquid used being slightly coloured. However, besides these two bands, both of these amido compounds gave a very clear band from 656 to 645, and it is certainly not without interest that this is coincident with one of the bands given by ammonia; whether any other band coincidences occur between these bodies we cannot say, as in both cases there was sufficient general absorption to hide them even if present.

Among other liquids we have tried turpentine, which appears to give a definite spectrum. This is shown at Fig. 13. With a thickness of 8 feet of carbon disulphide and a similar thickness of carbon tetrachloride, we could see no bands. However, with the former liquid it may prove that there is a band in the green, but as far as we could tell this is doubtful. One other experiment, which has some interest, is that the benzene spectrum is unaltered when the liquid is saturated with sulphur.

Such are the principal observations which we have made up to the present time. As stated at first, we look upon these results as preliminary, and as having to be repeated with more accurate means. Of course we have only dealt with the bands visible under ordinary conditions; still, the above results, as far as they go, have been made with much care, and we think show that most interesting relations exist between the chemical composition and constitution of a body and its absorption spectrum. Obviously a far more extended series of observations must be made before any general conclusions of value can be deduced. WILLIAM J. RUSSELL

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CELLULOID

THE product of the action of strong nitric acid upon cellulose has of late years met with many applications in the arts.

When cotton wool, linen, paper, or other substance largely consisting of cellulose, is immersed in strong nitric acid, a mixture of two or more nitro-celluloses is produced; a solution of this mixture in alcohol and ether has been long known as collodion.

About three or four years ago it was shown that this

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product may be dissolved under pressure and at moderately high temperatures in camphor, and that on cooling a hard, compact mass closely resembling ivory is produced. This observation furnished the starting-point in the manufacture of "Celluloid," a substance which has already been put to many and varied uses, and promises to be of much importance in the future.

In the process of Tribouillet and Besaucèle—patented in January, 1879—the raw material, consisting of paper, linen, cotton wool, hemp, or white wood, is dried at 100°, and is then nitrated in vessels of glass, clay, or glazed sheet-iron, furnished with a double bottom, between the parts of which water is constantly flowing. The nitrating acid consists of a mixture of 3 parts concentrated sulphuric acid (sp. gr. = 1·834) and 2 parts concentrated nitric acid, containing nitrous acid. The dry and finely-divided material is first treated with acid which has been already once used for nitrating; the materials are mixed for ten or fifteen minutes by the help of a kind of trowel; the mass is pressed in a glazed iron cylinder with perforated sides and bottom, through which the acid runs out. The material is again treated with a fresh mixture of acids in the proportions already mentioned; it is then washed with water in a series of wooden vessels with perforated bottoms placed one beneath the other on an inclined plane. The last particles of acid are removed by washing with very dilute soda or ammonia, and again with water. The material is then dissolved in appropriate solvents, from which it is again recovered in a paste-like form, by distilling off the solvent.

For making artificial ivory and similar opaque substances, about 100 parts of the prepared nitro-cellulose are intimately mixed with from 42 to 50 parts of very finely-divided camphor, and the mixture pressed in a warm press, into which steam is conducted, and which is connected with a moist chamber wherein the fumes from the press are condensed. After being for some time in a warmer press, the material is dried in a chamber containing calcium chloride or sulphuric acid, and connected with an air-pump.

Other manufacturers appear to mix ivory-dust, nitrocellulose, and camphor, and to press the mixture when moist, heat it with ethyl nitrite in a closed vessel until perfectly homogeneous, and distil off the nitrite.

Celluloid is a hard, perfectly homogeneous substance, which is not attacked by ordinary reagents (it dissolves slowly in cold concentrated sulphuric acid), cannot be easily broken, and becomes plastic at about 125°. It may be obtained in thin layers 0·5 millims. in thickness, which may be encrusted on wood, marble, &c. At about 140° celluloid suddenly decomposes, emitting a reddish vapour; this liability to complete decomposition may be prevented by washing the celluloid with sodium silicate solution and then immersing it in a solution of sodium or ammonium phosphate; thus treated, the material is non-inflammable.

If colouring materials be mixed with the celluloid during the manufacture, artificial coral, amber, malachite, and *lapis lazuli* may be prepared.

Celluloid is an admirable material for forming the backs of brushes, handles of knives or umbrellas, combs, playthings for children, &c.; it is also employed in America as a substitute for linen in the manufacture of collars, scarves for the neck, &c. Articles made of it may be washed with soap and a brush, and are practically indestructible. M. M. P. M.

L. F. DE POURTALES

[OUR readers will be glad to have the following further notice of the late Count Pourtales from his intimate friend and colleague, Prof. A. Agassiz.—ED.]

Louis François de Pourtales died at Beverly Farms, Massachusetts, in the fifty-seventh year of his age, on July 17, 1880. Spite of a magnificent constitution and a manly vigour of body and mind which seemed to defy disease and to promise years of activity, he sank, after a severe illness, under an internal malady.

Educated as an engineer, he showed from boyhood a predilection for natural history. He was a favourite student of Prof. Agassiz, and when his friend and teacher came to America in 1847, he accompanied him, and remained for some time with the little band of naturalists who, first at East Boston, and subsequently at Cambridge, shared his labours.

In 1848 Pourtales entered the U.S. Coast Survey, where his ability and indefatigable industry were at once recognised, and he remained attached to that branch of our public service for many years. He then became deeply interested in everything relating to the study of the bed of the ocean. Thanks to the enlightened support of the then Superintendent of the Coast Survey, Prof. Bache, and of his successors, Prof. Peirce and Capt. Patterson, he was enabled to devote his talents and industry to the comparatively new field of "thalassography" and the biological investigations related to it. The large collections of specimens from the sea-bottom accumulated by the different hydrographic expeditions of the U.S. Coast Survey were carefully examined by him, and the results were published, in advance of their appearance in the Coast Survey Reports, in *Petermann's Mittheilungen*, accompanied by a chart of the sea-bottom on the east coast of the United States.

So interesting and valuable were the results obtained, not only as an aid to navigation, but in their wider bearing on the history of the Gulf Stream and on the distribution of animal life at great depths, that in 1866 he was sent out by Prof. Peirce, then superintendent of the Coast Survey, to continue these investigations on a larger scale. During 1866, 1867, and 1868 he was in charge of the extensive dredging operations carried on by the U.S. Coast Survey Steamer *Bibb*, acting-master Platt, along the whole line of the Florida reefs and across the Straits of Florida to Cuba, Salt Key, and the Bahama Banks. The results of these expeditions, published in the *Bulletin* of the Museum of Comparative Zoology, excited great interest among zoologists and geologists. M. Pourtales was indeed the pioneer of deep-sea dredging in America, and he lived long enough to see that these expeditions had paved the way not only for similar English, French, and Scandinavian researches, but had led in this country to the *Hassler*, and finally to the *Blake* expeditions, under the auspices of the Hon. Carlile P. Patterson, the present Superintendent of our Coast Survey. On the *Hassler* expedition from Massachusetts through the Straits of Magellan to California, he had entire charge of the dredging operations; owing to circumstances beyond his control, the deep-sea explorations of that expedition were not as successful as he anticipated.

At the death of his father M. Pourtales was left in an independent position, which allowed him to devote himself more completely than ever to his zoological studies. He resigned his official connection with the Coast Survey and returned to Cambridge, where he became thenceforth identified with the progress of the Museum of Comparative Zoology. To Prof. Agassiz his presence there was invaluable. In youth one of his favourite pupils, throughout life his friend and colleague, he now became the support of his failing strength.

The materials of the different deep-sea dredging expeditions above-mentioned had been chiefly deposited at the Museum in Cambridge, and were thence distributed to specialists in this country and in Europe. A large part of the special reports upon them have already appeared. M. Pourtales reserved to himself the Corals, Halcyonarians, Holothurians, and Crinoids. A number of his papers on the deep-sea corals of Florida, of the

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